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FINANCIAL, FISCAL AND OTHER ECONOMIC MEASURES
AND POLICIES INCLUDING SUBSIDIES AND COMPENSATION

Discussion paper submitted by Sweden

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Note: The views expressed in this paper are the author's own and not necessarily those of the Swedish Government.

Introduction

1. During recent years the questions of environmental problems have become major issues in public debate and policy-making in a large number of countries. This is not the place to discuss or explain this growing interest, but it goes without saying that environmental policies probably will continue to be major issues in the coming decade. The increased knowledge and awareness of different environmental cause-effect-relationships will have a substantial effect on economic planning and allocation in all countries, regardless of their economic-political organization, and on governments' efforts to increase welfare, defined in a broad sense.
2. A comprehensive discussion of environmental problems and policies should at least contain the following aspects:
 - (a) technological, physical and biological cause-effect-relationships between different economic activities and the human environment;
 - (b) an evaluation of the social and economic consequences on the human environment of different feasible activities, and the possibilities of comparing the costs and benefits of these activities with others affecting human welfare;
 - (c) the choice of an organizational framework to select those activities that are favourable (or least disfavourable) from an overall point of view, taking into consideration all individuals' welfare; or to suppress those activities that are obviously harmful or whose effects are uncertain, but which might cause different kinds of long-term damages.
3. This paper concentrates on the last-mentioned aspects of environmental problems; even further, on a subset of environmental problems mainly related to the imperfect allocation in a decentralized economic system of some factors of production; commodities or goods such as water, air, land, etc. Despite this limitation it is still the hope that the discussion will have some bearing on other aspects of human environment, e.g. those connected with physical planning and urbanization.
4. Economists have long been aware of different reasons for failure to attain a social-economic optimum by the use of decentralized decision-making combined with a pricing-mechanism. The conditions for attaining a social optimum by atomistic behaviour in "free" markets or by a far reaching decentralization in the planning procedure are rather restrictive and as soon as some of the basic assumptions are not fulfilled there is a strong argument for central corrective measures or planning. In principle the arguments for centralized decision-making or corrections in the field of environmental

economics are very much the same, whether the economy is organized mainly on the basis of independent private enterprise or on a decentralized model of the socialist type.

5. As the main concerns of this paper are the arguments for corrective action or centralized planning necessitated by environmental problems (disregarding other problems of market failure created by monopoly, indivisibility, etc.) it is possible to discuss a common problem of the need for centralized environmental policies in economies with decentralized decision-making, in which firms or enterprises aim at a maximum of profits at prices either given by "the market" or by an efficient price control board. A main question will then be to investigate if operation rules for the enterprises ought to be changed and/or whether it is possible to attain optimal corrections by other means.

6. Economic problems are problems of allocating scarce resources between different production and consumption activities and of distributing the welfare thus created among the citizens. This statement may seem quite trivial, but it may still function as a starting point for a discussion of environmental problems. By such a general approach to economic problems, there is no real conflict between, on the one hand, welfare created by the consumption of commodities allocated by "market mechanisms", and on the other hand, welfare created by the consumption or the final use of commodities which for different reasons are allocated by other mechanisms. If this point of view is accepted, environmental problems are part of the more general economic problem of allocation and distribution; the effects on human welfare of different states of environment should and could be treated together with other options to influence economic welfare.

7. Still the problems of measuring human welfare created by different states of the environment are to a high degree unsolved. The market mechanism - beside its allocation and distribution role - produces values determined by quantities and prices in the market. These can be used as approximations of individual welfare and even aggregated into more national or global measures as GDP etc. Although this market approach fails, for environmental resources, it must be underlined that improvements in indirect measurement techniques - e.g. reliable estimates of "consumer surpluses" and opportunity costs - may considerably shift the present borderline between tangibles and intangibles. Another approach is the formation of different kinds of political bodies, representing diversified interests and aiming at stable compromises, as substitutes for market evaluations or theoretically more sophisticated measurement methods. In any case there seems to be very little rational argument for allowing the present book-keeping rules of national accounts to determine what in a more general context should

or should not be classified as economic welfare. Another supporting argument for this attitude is that the borderline between the market mechanism and other allocation mechanisms is shifting.^{1/}

8. In the following sections there will be a very short discussion of some principles underlying the economic arguments for and assessments of different environmental policies. Then follows a brief presentation of some of the major causes behind "market failures" as far as environmental problems are concerned. Further on there is a more comprehensive discussion of different corrective measures available. In this context environmental policies are defined from an economic point of view: as measures for the implementation of optimal use of environmental resources, mainly by correcting decentralized decision-making and thereby increasing welfare and improving the functioning of the economy.

A. Criteria for evaluation of environmental policies

9. An economy will be said to be in an optimal state if it is not possible by some reallocation of resources to improve the welfare - defined in a very broad sense and including the individual consumption and evaluation of environmental resources - for any person without decreasing welfare for anybody else, and the income and wealth distribution is judged as being satisfactory. The main argument in environmental economics is that the economy due to incompleteness in the market mechanism cannot achieve such a state, and that different types of corrections therefore must be implemented. For evaluating such corrections any of the following criteria may be used:

- (a) welfare is increased if a measure increases welfare for at least one person without decreasing welfare for anybody else. This very restrictive criterion for desirable welfare changes - generally called the Pareto-criterion - assumes that everybody hurt by a decision or a change gets full compensation.
- (b) (potential) welfare is increased if a measure causes a welfare increase for some individuals, large enough to compensate the losses for other individuals, even though the corresponding compensations are never paid. In general, this is the type of criterion - a positive net of total gains or benefits minus total losses, with benefits and costs evaluated in money terms - that lies behind most benefit-cost analysis. (An often used argument for this criterion based on potential

^{1/} Problems of assessing costs and benefits are subject to a comprehensive treatment in other papers for the Conference and will not be dealt with in this paper.

rather than actual compensation is that the appropriate change in income distribution (to compensate the losers by confiscating parts of the benefits from the gainers) is best done by a general redistribution policy through taxes and subsidies correcting unwanted distribution effects from all different kinds of allocation policies);

- (c) a more sophisticated criterion, than to assume that a gain of one money unit for one person outweighs the loss of one money unit for another person, is to use an explicit weighting of gains and losses, with weights given by some political preference function defined over possible income distributions.

10. Without recommending or taking a firm position for or against any of the criteria discussed it seems necessary to remember that most measures of environmental policies have allocation as well as distribution effects and that one must be aware of the necessity in many cases to support allocative environmental policies with compensatory or redistributive measures to create a better understanding and acceptance of the allocation aspects.

11. Economists have for a long time made substantial efforts to investigate the conditions for a highly decentralized decision process in the economy to generate so-called pareto-efficient states; i.e. a state in which no one can be better off, without a decrease in welfare for somebody else. In such a pareto-efficient state all possible changes that would fulfil a strict pareto-criterion (the criterion (a) above) are at an end. The conditions for the existence of such a state are very similar to the conditions for an optimum of what is called a competitive equilibrium in a private ownership economy or a scheme of decentralized price allocation in a socialist economy. In such economies households choose consumption bundles in order to maximise utility at given prices and firms choose production programmes in order to maximise profits at the same set of prices. The most important conditions for the existence are usually formulated as:

- (a) all kinds of transactions affecting resource allocation takes place in the market (the market is "complete");
- (b) returns to scale do not exist in production and consumers have what somewhat vaguely may be called decreasing marginal utility of consumption of the different commodities.

12. This second condition is of less interest in this context, and will not be discussed further, while the failure of fulfilment of the first-mentioned condition is of basic

relevance for environmental economics. This condition may also be interpreted as that the set of commodities affecting the consumer's welfare shall be identical with the set of commodities he can buy (or sell) in the market. For a producer a possible interpretation is that the production programmes shall be technologically independent of choices of other firms or households in the market.

B. Environmental problems and market failure

13. In this section a number of different reasons behind the failure of atomistic market behaviour (or highly decentralized planning) will be mentioned. Within this limited space it is not possible to give a comprehensive or complete description and the problems can only be illustrated by some single, "typical" examples.

(a) Externalities

14. The economic analysis of environmental problems and policies often take its starting point in the concepts of (technological) external (dis)economies or external effects. The problem is often described as one in which there is some kind of interdependence between the production possibilities of different enterprises (or between enterprises and consumers etc.) and that these interdependencies are not directly reflected in the price system. The concept of external effects has a long history in economics, stretching from Pigou and onwards, often with drastic examples taken from the field of pollution, but it seems as though economists for a long time thought of the problems of externalities as highly marginal ones and were not recognising the full impact of the size of externalities (and consequently the non-optimal behaviour of decentralized decision procedures).

15. In a discussion of appropriate policies, the explanation of external effects as merely interdependencies outside the market price system is not fully satisfying or complete. Another, more direct approach is, as a first approximation, to divide all commodities into two groups; the first group containing all commodities allocated by a market process, the other group - including "environmental" commodities - allocated by some other allocation procedure. One of the main tasks of environmental economics is then to study the character of these non-market allocation processes and to see whether they can be improved by various measures.

16. The economic problems of environment is thus looked upon as one of the (highly) incomplete price and market systems, with a subset of commodities traded and allocated in the market and another subset of commodities (among these the "environmental commodities") allocated by some other methods.

17. One of the main difficulties concerning these "environmental" commodities is that ownership - private or public - is difficult or extremely resource-demanding to enforce. A related problem is that the cost of excluding one producer or consumer from using a commodity is technically impossible or is combined with such high resource costs that the existence of a market is not worth while.

18. The case of air is a good example of these difficulties - a complete control of individual use of clean air as a factor of production and the production of different types of polluted air as a by-product is not an easy task, and without any restrictions clean air will be treated by different agents as a "free" factor of production. In general this will mean that different users will not get any information about the value put on clean air by other agents in the economy. Easily the economy may get into a state in which some users of clean air - e.g. households in certain areas - would find it worth while to bribe some other users of clean air - e.g. polluting industries - to diminish their demand. But the problem is that except for very simple cases no market mechanism or negotiation scheme is available for such mutual adaptation towards overall optimality.

19. The problems of air pollution are still more complicated by the high propensity of pollution to affect vast regions over national borders. Similar problems, but less pronounced, are met in the use of water and land. Another example of the lack of individual possession is the different kinds of aesthetic experience. Beautiful sights and aesthetically attractive urban planning are phenomena very close to economists' concept of public goods. In general it is not possible to vary the potential individual consumption, but the amount of the commodity totally available must be decided upon by a collective.

(b) Long-term effects

20. Another problem of the market-system is that it is incomplete regarding long-term decisions and long-term effects. To give a drastic example: the unborn generations have no say in an atomistic market process; yet many of the decisions made today affect coming generations. This may be specifically true regarding problems of deterioration of environment and different types of highly irreversible processes. The general market test - if the groups, whose standard is decreased by actions of another group can be compensated by the latter group to accept the change (or the other way round: if the latter group can be bribed by the former group not to undertake the actions) - fails for obvious reasons, as the unborn generations are very weakly

represented in the market (except for parents' concerns for their children) and need some protecting representative or "ombudsman". This is a very obvious case for the central authority to intervene and increase the time perspective in the planning. The problem now mentioned is of course met in many other parts of the economy, but it seems rather safe to argue that the quantitative importance of the market's failure to take account of long-term consequences is greater in the environmental field (partly due to irreversibilities) than in most other parts of the economy.

(c) Communication and information

21. Environmental problems also challenge the whole concept of "consumers' sovereignty".

An idealized picture of the consumer assumes an "economic man" with a full knowledge of the cause-effect-relationships between his consumption activities and his own level of living. Such an assumption might be a good approximation in many cases, but many problems labelled as "environmental" problems have been concerned with cases - e.g. mercury-content of fish - where the purely technological and physiological relationships have been uncertain or disputed among experts. Similar problems are met in other areas, but there is a close connexion between a "free use" of some environmental commodities and the spread of toxic substances to marketable commodities.

22. Market failure is caused by the uncertainty regarding the qualities of the commodities produced and consumed in the market. This failure can be only partially avoided by far-reaching specification of the quality of the commodities, as the consumers still may lack the technological and physiological knowledge to evaluate the information.

23. The problems discussed here can be looked upon as two, partly different types of "transaction costs" in the economy. The first two groups of problems (a and b) concern the high costs for exclusion, making the usual market mechanism not worth while for many allocation purposes. Other solutions for allocation procedures have to be sought. The third group concerns the high costs of communication and information, especially the problem of informing all agents about the intricate causal relationships that may adhere to some transactions and consumption activities. To avoid this type of market failure it may in many cases be more efficient to reduce information necessary for consumers by standardizing products or giving guarantees that products fulfil certain standards fixed by authorities.

C. Policy measures

24. In the preceding sections environmental policy was defined as a set of measures aiming to improve the functioning of the economy according to certain welfare oriented criteria. To correct for the different types of market failure discussed above it is possible to use measures with quite different properties. In the following paragraphs the different measures - regulations, taxes, affluent fees etc. - will be discussed with regard to their effects on allocation and distribution.

25. The diagram in fig. 1 gives a highly simplified picture of some of the commodity flows in the economy and may serve as a starting point in a discussion of some economic aspects of different measures in environmental policies.^{2/} The main problem - as indicated above - is that the environmental commodities used in the production system are in general allocated by other mechanisms than the usual market mechanism. The potential misallocation effects can be of different kinds.

26. Some production processes, that have an "easy" access to environmental commodities use "too much" and other production processes get too little. A good example is given by enterprises situated upstream deteriorating the quality of water for users downstream and forcing other potential consumers to operate a waste treatment process. Environment may be degraded to such an extent that environmental services directly used by consumers get scarce. Even though enterprises and consumers may start negotiations to have a joint allocation of fresh water and joint planning of waste treatment activities, direct consumption (e.g. recreational purposes) might be severely diminished.

27. In some cases environmental commodities may be produced - e.g. improving urban environment or restoring earlier destroyed lakes etc. - but with the public goods character of the environmental commodity, these decisions will in general not be produced by the market mechanisms, but have to be taken by some arrangement for collective decisions and financing.^{3/}

^{2/} Similar diagrams have been published in "Environment conservation in Sweden during the 70's" (Ministry of Finance, Stockholm, 1971) and in a number of recent articles. Consumers' own production is for reasons of simplicity regarded as parts of the production system.

^{3/} An interesting example is given by the restoration of the Lake Trummen in Southern Sweden. This restoration is potentially profitable if it is possible to "confiscate" 10-20 crowns a year from every person in the planned residential area close to the lake, i.e. less than the extra cost of two trips/year to an unpolluted lake.

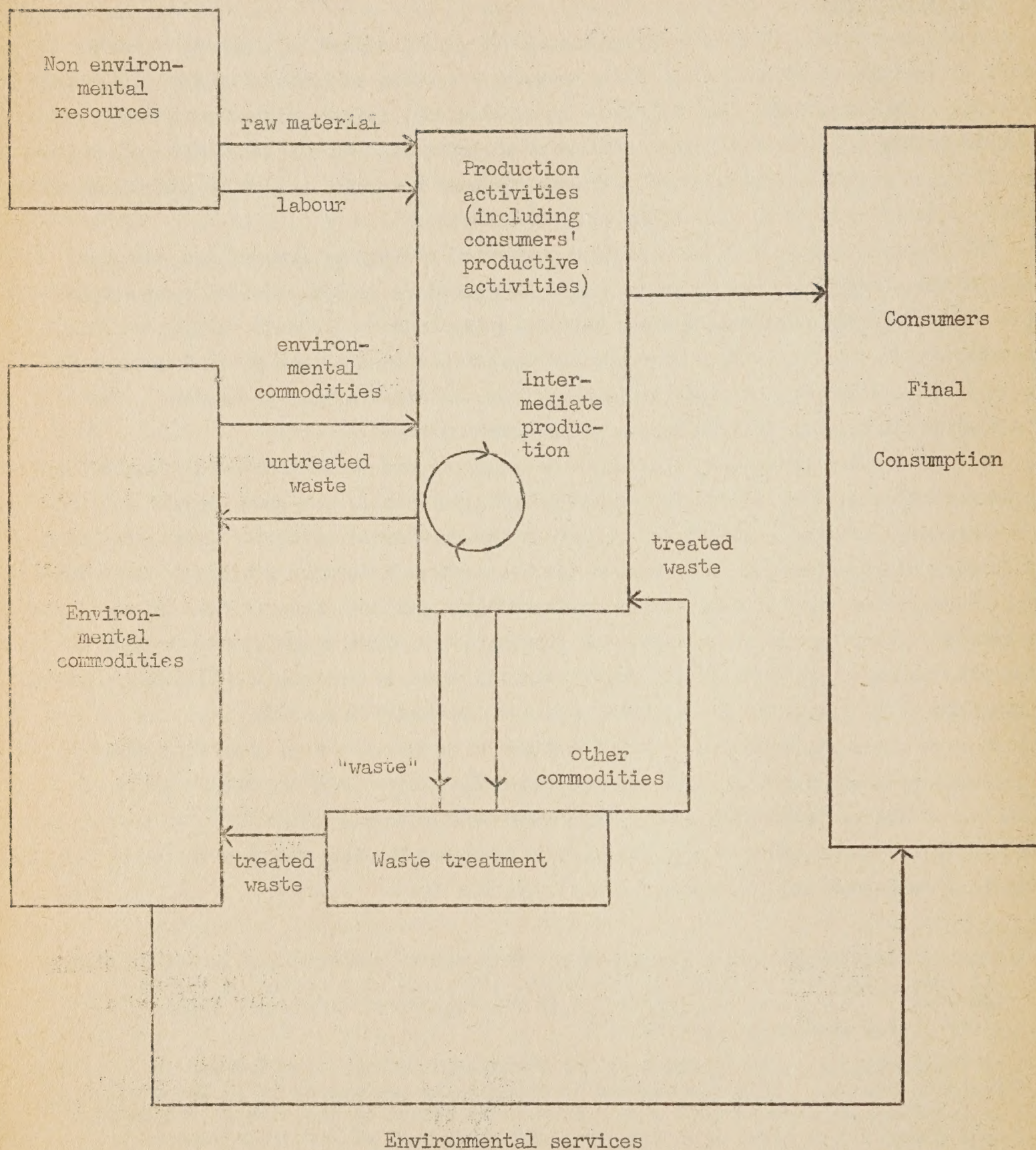


Fig. 1. Simplified commodity flow diagram.

28. In general the economy will produce too much of the marketable and appropriate commodities and too little of environmental commodities will be left (or produced). But within the "market sector" of the economy relative prices will also change and give a bias in consumption. Products using much of environmental commodities will be cheaper than in an economy at overall optimum.

29. Environmental commodities are characterized by the fact that they can take on a number of different qualities - different degrees of pollution as well as different kinds of pollution - and that they are used for direct "consumption" or used by the producers as intermediate goods in different production processes, mainly as media for waste disposal, but in some cases also as more direct factors of production. Another characteristic of these commodities is the lack of what can be called (full) appropriability; the costs for excluding one consumer or producer from using the commodity may be very high. It is obvious that the exclusion costs for the use of air are very high for technological reasons, though a development of quality monitoring systems may change this property gradually. As regards water the question is much more a matter of degree; geographically confined lakes and running streams are much easier to make into appropriable commodities than the vast oceans. Land is a highly appropriable commodity for many activities - property laws regarding land are basic for most countries - but the exclusion cost may be very high when it concerns the disposal of some solid waste like disposable bottles or when it concerns the allocation of road space in a traffic stream.

30. The different types of solutions suggested and to a certain extent also implemented can be classified in the following groups:

(a) Measures aiming at an inclusion of the environmental commodity in the price system, mainly by extending property rights and a legal framework for negotiations. In general these measures tend to place environmental commodities in a situation similar to other natural resources which for some reasons are appropriable commodities.

(b) Another group of measures consists of different types of physical and quantitative regulations on different production activities, e.g. prohibition of some activities in certain areas, regulations on the maximum amount of some resources used or maximum amount of some effluent.

(c) A third group of measures includes different types of taxes and subsidies to correct to correct the atomistic market behaviour. Taxes (or subsidies) are in general not applied to the environmental resource itself, but to some substitution or complementary commodity, or to the production activity itself. Another possibility is to subsidize

waste treatment processes. Taxes and subsidies may be applied with different degrees of generality, ranging from say a general tax on sulphur in oil or lead in petrol to highly discriminatory taxes and subsidies, calculated for each individual activity.

(d) A final way of correcting the failures of atomistic market behaviour is to change the incentive structure of enterprises; i.e. to make them "environment-conscious" by basing the operation plans not on observed private profitability but on calculated social profitability. A discussion of this point, however interesting, goes far beyond a study on correcting behaviour of profit maximizing activities in a market economy.

In the following paragraphs the different approaches will be treated at some length.

(a) Inclusion in the price system

31. It is obvious that the economists' straight forward prescription is that the inappropriable commodities should be turned into appropriable commodities by extension of property rights and an inclusion into the market allocation system. As has been

discussed at great length in the economic literature on external economics the allocation problem may sometimes be rather easily solved if the number of parties concerned is small, but a solution based on direct negotiations between the parties involved is not practicable if the use by one agent of a non-priced commodity affects many parties spread over big areas or the effects occur over a long period of time.

32. A sine qua non for such a policy is a legal framework defining property rights, giving rules for negotiations - directly between the parties or in court - and determining the procedure for calculations and payments of compensation. A main point is that the legal system determining property rights and compensation measures should be looked upon as an integral part of the allocation mechanism.

33. If the parties are limited in number it seems reasonable that - with a proper legal system - it would be possible to come close to paretosuperior solutions; i.e. a solution in which nobody is worse off, but some may be better off. Such solutions presuppose that compensation is actually paid out or that parties, who might be damaged, induce the damaging party to accept a solution that is closer to an overall optimum. The direction of the monetary flow is highly dependent on institutional conditions (e.g. "who was there first") and the definitions and the extension of property rights. //

// Regarding the direction of compensations considerable differences may exist between countries with extensive private property rights (e.g. private ownership of lakes, streams, etc.) and countries with state or some other kind of public ownership.

34. When the number of parties increases it is for many reasons more difficult to reach paretosuperior solutions. Direct negotiations become impractical, difficulties in assessing the damages in economic terms become more and more difficult and it may even be impossible to identify all parties harmed. The pure technological-ecological relationships may be uncertain.

35. Still the idea of having a market solution might not be entirely lost if negotiations can be done between the party who is going to use some environmental resources, thereby decreasing their quantity or quality, and any kind of organization (municipality, the state or some kind of organization - e.g. a natural resources conservation board or an environment agency) acting as a representative for the parties who are going to suffer some kind of damage and decrease in their welfare.

36. Inclusion of the environmental commodity into the market system and the formulation of representative bodies for the public interest or for the interest of groups suffering potential damages with payments of compensations seem to be a solution that in many countries has been applied to water, mainly in connexion with construction of hydro-electric power stations. An example of a policy of this type is given by the Swedish Water Act from the beginning of this century. This act was a forerunner of the present and more general Environmental Protection Act. The main ingredients of the policy can be said to have been a simultaneous establishment of property rights and negotiation rules before a court. But it must also be observed that the scope of pure paretosuperior solutions with actual compensations being paid out in general have been limited, as compensations have been tied to ownership of fixed property. Regarding more intangible damages - loss of beautiful landscapes, etc., the general rule seems to have been to accept a welfare criterion based on potential rather than actual compensation (cf. the discussion in Part A).

37. The method described can also be said to be a way of establishing a market for rights of pollution with the "polluter" compensating at the margin the social costs of damages to other parties in the economy. In general an approach of this type will ensure not only optimal use of environmental resources but also contain enough incentives to enforce optimal waste-treatment. As has already been pointed out this policy may include the creation of special market agents taking care of the interests of persons who for different reasons cannot express their preferences in the market. The creation of a system of legal property rights may also have profound consequences for the distribution of wealth in society and some kind of collective ownership may be necessary. An obvious

advantage of the market approach is that a high degree of decentralization in decision-making can be preserved. The main problem of this market approach is still whether the transaction and exclusion costs are small enough to make it worthwhile for the market to take into account both the improvements in allocation and the costs of operating or simulating a market. Productivity increases of different types of monitoring systems may however in the future increase the scope for market approaches.

(b) Regulations

38. The dominant approach in environmental policies up till now seems to be the use of different types of regulation - including licences or permits for different types of activities having pollution effects. The Swedish country monograph gives a number of examples:

- (i) Banning of some types of chlorinated hydrocarbons.
- (ii) Licences or permits for all owners of fixed property with activities that may cause environmental damages through effluents into air and water or nuisance like noise. The principal rule for granting a licence is that if the activities have negative environmental effects the firm must select a site giving a minimum interference and disturbance on the environment, without incurring unreasonable costs. Protective measures, like waste treatment, must conform to the most recent technology. Without being explicitly stated, it seems as if the general welfare criterion used is of type (b) (potential compensations - see paragraph 9 of this document).
- (iii) A programme for gradual reduction of sulphur in fossil fuels, limiting the permissible sulphur content of fuel oil to 2.5 per cent by weight. Similar schemes are applied to other pollutants: e.g. setting a maximum level for carbon monoxide for new cars or maximum amounts of lead in petrol.

39. It goes without saying that the introduction of the measures mentioned increases welfare in a wide sense compared with a laissez-faire policy. With the general uncertainty regarding the harmful effects and with the lack of monitoring systems and of administration for a more sophisticated allocation system, an introduction of regulations may be accepted as a second best solution, taking into consideration different institutional restrictions.

40. But in a discussion on the economic consequences a distinction must be made between on the one hand temporary regulations and on the other hand more or less permanent permits or licences to conduct activities with environmental side-effects. A temporary regulation might for many cases be a first step, rather simple to administrate, giving a time of respite to collect more information and formulate more sophisticated policies. It must be kept in mind that the high degree of uncertainty of the pure technological, biological and ecological relationships in many fields of environmental policies severely limits the possibilities of finding the "true optimum". As more information is gathered, partly facilitated by the "controlled experiments" of introducing quantitative relations, it may be possible to adjust the measures used. Permanent licences will in general not give this possibility for flexibility in the future.

41. The problem of high transaction costs and exclusion costs in the "market solution" have their counterparts in measures relying upon quantitative regulations. In general it will not be possible to differentiate the amount of sulphur dioxide going out into the air over certain areas according to short-term meteorological conditions. Lead and carbon monoxide in exhaust gases may have substantially different ecological and welfare economic effects in a congested urban area than in a desolate area with no or little agricultural production. But regulations have to be simple with the result that all regulations of the type mentioned will give more than optimal pollution in some cases and less than optimal pollution in other cases. With full knowledge it will of course be possible to determine a second-best optimal regulation, minimizing the total welfare losses due to the standardization requirement. In a more sophisticated policy it may even be possible to determine an optimal scheme for differentiating regulations weighing the administration costs of increasing differentiation against the gains in welfare from increased differentiation.

42. To determine the optimum regulation, it is necessary to accept the concept of optimal pollution: at such an optimum the gains from increased production or use of polluting factors of production will be equal to the "social costs" of increasing pollution or deteriorating environmental qualities. Social costs are defined as the monetary value that can be imputed to the environmental damages, e.g. by determining the amount of compensation necessary to keep everybody on at least the same welfare level as before. The conditions have to be somewhat reformulated having regard to the possibility of waste treatment but such an optimal regulation is - in contrast to the "market solution" - based on potential rather than actual compensation. This has

also the implication that the methods differ substantially regarding their effects on income distribution. Giving a licence to a new activity, say supersonic air transport, on a benefit-cost criterion based on potential compensation, means that other human activities hurt by the new activity will not directly be compensated for the losses of environmental quality. Issuing a permit or licence, without claims for paying out compensations, will thus in general change the income and wealth distribution in favour of the owner of the permit.^{5/}

43. The question of effects on welfare distribution gets a little bit more complicated, if the regulation relates to already existing operations. In the case of regulating the contents of exhausts from cars, there is a gain for others if one had expected car owners to have permanent rights to free pollution. The question of gains and losses for different groups becomes a question of "who was there first" and what type of expectations regarding future policy that prevails.

44. The use of regulations necessitates a central body, formulating the regulations on the basis of careful investigations of a benefit-cost type. The needs for central economic analysis might be even greater with the use of regulations compared with an attempt to incorporate environmental commodities in the price system. Quantitative restrictions can also be looked upon as another way of steering the market towards an optimum. The usual price adjustment process depending on whether there is excess demand or excess supply in the market can be substituted with a quantitative steering process along the following lines:

45. The environment agency declares a set of quantitative restrictions valid for different producers in the economy. Each producer calculates for his enterprise the marginal cost of changing the restrictions. At the same time the environment agency conducts research on the marginal benefits of the restrictions. By comparing the benefits of a marginal change with the costs it may be possible to steer the economy towards our optimum. However, this adaptation process may be rather slow, as it takes time to estimate the ecological effects of changing restrictions. If marginal costs are higher than marginal benefits - estimated in surveys or determined by a political body - the restrictions will have to be relaxed; if marginal benefits are higher than costs the restrictions have to be tightened^{6/}. But still the question of income-distribution effects has to be solved.

5/ A market for permits and licences, with a national environment board as representative for the individuals and firms hurt, is one possible alternative of the market solution, treated in the preceding section.

6/ Adjustment procedures of this kind are well known from other fields of economic planning. Cf. Kornai's models for long-term planning in Hungary.

(c) Taxes and subsidies

46. In this paper a clear distinction is made between, on the one hand, using prices for environmental commodities, like effluent charges, and on the other hand the use of taxes or subsidies on goods that are complements or substitutes to the environmental commodity. These latter methods are indirect ways of correcting market behaviour where it is too difficult to monitor and charge the effluent more directly. By shifting the relative price structure with increases in prices on complements and decreases in prices on substitutes it will be possible to use less of the environmental commodity and/or produce less pollutants and thereby bring the economy closer to an optimal position. Examples of such measures are taxes on lead in petrol (rather than charges on lead compounds in the exhaust gases), taxes on sulphur in oil (compared with charges on sulphur-dioxide in smoke), subsidies for waste treatment etc. But examples are easier to find in theoretical discussions than in real life.

47. The main administrative problem of taxes and subsidies seems to be very much the same as with the use of regulations. The discussion on sulphur dioxide in smoke gases can elucidate the problem: a tax on the sulphur content in oil can either be the same for all users or it is differentiated between different users according to the risk of damage. It seems reasonable that a user in a densely populated conurbation area should have a higher tax rate than a power plant far from population centres and industrial activity. But a discriminatory tax-system with indirect taxes differing between users will violate one of the basic conditions for a competitive price system, with a risk of trading outside the market between users with high rates and those with low rates. The solution - except for cases when trading between agents is not possible - seems to be to have a uniform tax rate, with the result that pollution will be more than optimal for some users and lower than optimal for others. A theoretically interesting approach is however to use more complicated tax structures, e.g. taxing and subsidizing more than one factor of production related to the environment commodity. (e.g. a scheme of taxes (or subsidies) on sulphur in oil, chimney heights, different types of burning equipment etc.). Such a more sophisticated tax structure will bring the economy towards an overall optimum, but at the price of increased administration and interference with more markets on the part of the central agencies. As the environmental commodities cannot be priced directly, the question is to find a set of taxes giving as good an approximation as possible of a theoretical optimal price system.

48. By taxing polluting activities, it will be possible to force firms either to decrease the activities or to increase the operations of waste treatment. Subsidies can be used - and seem to be used to a much larger extent - for the same purpose, but with the community bribing the firms not to pollute, rather than forcing the firms to compensate the community for damages incurred. The Swedish country monograph give many examples of such subsidization policies in actual cases combined with regulations. This is not the place to discuss the pros and cons for taxes and subsidies, but still a few marginal remarks may be of value.

49. Environmental taxes will improve resource allocation and give the central authorities a possibility either to compensate "the losers" or use the revenue for other purposes. Environmental subsidies will also have a positive allocation effect, but will at the same time increase the demand for other tax revenues. In contrast with giving out subsidies, these taxes can hardly be imposed on a lump-sum basis, but have to take the form of increased rates of direct or indirect taxation. In general this means that other optimum conditions in the economy will be disturbed and there will be a delicate dilemma between improving resource allocation in one sector and deviating from optima in other sectors.

50. Most subsidies to waste treatment seem to be tied to investments. There are mainly two different types of risks connected with this type of policy compared with a subsidy to actual amounts of waste treated. Firstly, the policy gives little flexibility regarding future technological developments. Secondly, there is a risk of using too capital-intensive waste treatment processes when one factor of production is subsidized and not the output of the process itself.